DETAILED DESCRIPTION

[0001] [Industrial Application]
In this invention, the electric variation accompanying the biochemistry reaction of the substance
under test in a solution under test and a biological substance is measured.
Therefore, it is related with the biosensor which measures a substance under test.

[0002] [Description of the Prior Art]
Conventionally, the monotonous type biosensor shown in JP,61-50262,A is known as this kind
of a biosensor, for example. Namely, as shown in drawing 8, the monotonous type biosensor
100, The ceramics board 101, and the working pole 103 and the counter electrode 105 which
were formed on this ceramics board 101, The insulating layer 108 which insulates between the
above-mentioned working pole 103 and the counter electrodes 105, and the discrimination layer
107 which carried out spreading formation of the gel material which supported the biological
substance on the above-mentioned working pole 103, It was connected to the terminal area
109,111 of the above-mentioned working pole 103 and the counter electrode 105, respectively,
and has the electrical measurement part (graphic display abbreviation) which measures a current
value in the meantime.
The above-mentioned discrimination layer 107 side serves as the induction part 113.

[0003]the above-mentioned biosensor 100 can measure the substance under test reacted to it by
boiling and changing various biological substances of the discrimination layer 107. For example,
if glucose oxidase is used for a biological substance, it will become a glucose sensor which
measures glucose.

[0004]The measuring method at the time of applying the above-mentioned biosensor 100 to a
glucose sensor is explained. In order to measure glucose in urine using this biosensor 100, the
induction part 113 of the biosensor 100 is immersed in urine, or urine is covered over the
working pole 103 and the counter electrode 105. Thereby, the glucose contained in urine
oxidizes by the catalysis of glucose oxidase in the discrimination layer 107, and decomposes into
glucono lactone and hydrogen peroxide. Glucose is measured by measuring the current value
accompanying this reaction in an electrical measurement part.

[0005] [Problem(s) to be Solved by the Invention]
By the way, ionic substances, such as sodium and potassium ion, and a substance with reduction

nature, such as ascorbic acid, usually exist in urine. The substance of such ionicity and reduction nature affects the biochemistry reaction by the biological substance supported by the discrimination layer 107, or acts as an interfering substance which makes current lead to the working pole 103 regardless of a living body chemical reaction. For this reason, even if it was going to measure glucose directly from urine, a mistaken measurement result was brought and there was a problem of being incapable measurement.

[0006]In order to solve this, it was coped with by removing the interfering substance in a solution under test with pretreatment conventionally, and the work was complicated.

[0007]This invention makes it a technical problem to solve the above-mentioned conventional art.
The purpose is to provide the biosensor which can eliminate the influence of the interfering substance in a solution under test, and can measure a substance under test in high accuracy.

[0008] [Means for Solving the Problem]
This invention made in order to solve an aforementioned problem equips with the following a biosensor which measures a substance under test by measuring an electric variation accompanying a biochemistry reaction of a substance under test in a solution under test, and a biological substance.
One pair of electrodes.
A discrimination layer which was formed in one surface of this electrode, and supported the above-mentioned biological substance.
A gate electrode in which voltage which forms a potential barrier to which it is provided in the circumference of this discrimination layer, and an electrifying substance in a solution under test is made to **** is impressed.

[0009] [Function]
The biosensor of this invention forms in one side of one pair of electrodes the discrimination layer which supported the living thing substance. If this biosensor is immersed in a solution under test, the above-mentioned living thing substance and the substance under test in a solution under test will carry out a biochemistry reaction, and a substance under test will be measured based on the electric variation generated in inter-electrode [accompanying this reaction]. In this invention, the gate electrode is provided, predetermined voltage is impressed to this gate electrode, and the potential barrier is formed in it so that a discrimination layer may be surrounded. This potential barrier acts so that the electrifying substance in a solution under test may not approach a discrimination layer. Therefore, disturbance of an electrifying substance affecting the biochemistry reaction of a living thing substance and a substance under test, or this reaction making current lead to a working pole independently etc. is not caused. Therefore, this biosensor can measure a substance under test correctly without being influenced by an electrifying substance.

[0010] [Example]
In order to clarify further composition and an operation of this invention explained above, the suitable example of this invention is described below.

[0011]<u>Drawing 1</u> shows the top view of the induction part of a biosensor, and <u>drawing 2</u> is the sectional view which met the II-II line of <u>drawing 1</u>. The working pole 5 where the induction part 1 of the biosensor was laminated on the insulating substrate 3 and the insulating substrate 3, It laminated on the working pole 5, and it was formed in the upper part side of the window part 9 of the discrimination layer 6 which supported the biological substance, the insulating layer 11 which is laminated on the above-mentioned insulating substrate 3 and the working pole 5, and has the window part 9, and the insulating layer 11, and has the gate electrode 20 which has the opening 21, and the counter electrode 30 formed on the insulating layer 11.
The space surrounded by the above-mentioned window part 9 and the upper surface of the discrimination layer 6 serves as the test chamber 40.

[0012]The above-mentioned discrimination layer 6 is a layer which supported the biological substance which carries out a biochemistry reaction with the substance under test in a solution under test.

For example, it is the layer which supported glucose oxidase with sol-like cellulose and carried out dry solidification.

The above-mentioned working pole 5 and the counter electrode 30 are formed from the wiring sections 5c and 30c which connect between the primary detecting elements 5a and 30a immersed in a solution under test, the terminal areas 5b and 30b, and the primary detecting elements 5a and 30a and the terminal areas 5b and 30b, respectively. The gate electrode 20 is formed from the gate section 20a, the terminal area 20b, and the wiring section 20c. The terminal areas 5b and 30b of the above-mentioned working pole 5 and the counter electrode 30 and the terminal area 20b of the gate electrode 20 are connected to the electrical measurement part (graphic display abbreviation). This electrical measurement part measures the current which flows between the working pole 5 and the counter electrode 30, impressing prescribed voltage to the gate electrode 20.

[0013]Next, the manufacturing process of the induction part 1 of the above-mentioned biosensor is explained according to <u>drawing 3</u>.

(1) The formation process of the insulating substrate 3 (<u>drawing 3</u> (A))
First, the insulating substrate 3 is formed. The method of starting the plate which consists of glass, resin, or those composite materials as a formation process of this insulating substrate 3, or calcinating the green sheet of ceramics is employable.
[0014](2) The formation process of the working pole 5 and the counter electrode 30 (<u>drawing 3</u> (B))

The working pole 5 is formed on the insulating substrate 3. As a formation process of the working pole 5, well-known thick film printing, vacuum deposition, sputtering process, etc. are employable. As a material of the working pole 5, those alloys, such as gold, platinum, palladium, silver, titanium, aluminum, zinc, nickel, and tin, can be used. The counter electrode 30 is also formed on the insulating substrate 3. The thick film printing same as a formation process of the counter electrode 30 as the working pole 5 mentioned above is employable. The counter electrode 30 is formed on the insulating substrate 3 simultaneously with the working pole 5, and

also it may form in a cylindrical electrode or it may be formed in an another insulating substrate and base material.

[0015](3) The formation process of the insulating layer 11 (drawing 3 (C))
The insulating layer 11 is laminated on the insulating substrate 3 and the working pole 5. The method of making carry out the prescribed thickness deposition of the insulating material with the method of forming by forming the plate which consists of insulating materials as a formation process of the insulating layer 11, and pasting this up, the method of only prescribed thickness applying melting resin and forming a layer, vacuum deposition, or a CVD method, and forming, etc. are employable. As a material of the insulating layer 11, glass, ceramics, resin, or these composite materials can be used, for example. As for the insulating layer 11, at this time, it is desirable to form with the same material as the insulating substrate 3. This is because the junction nature of the insulating layer 11 and the insulating substrate 3 improves.

[0016](4) The formation process of the gate electrode 20 (drawing 3 (D))
The gate electrode 20 is formed on the insulating layer 11. As a formation process of the gate electrode 20, the same method as the working pole 5, i.e., thick film printing, sputtering, vacuum deposition, etc. are employable. The opening 21 of the gate electrode 20 may be formed like drawing 1 circularly, a polygon, slit shape, or the shape of a lattice other than a square. As a material of the gate electrode 20, gold, platinum, palladium, copper, iron, silver, titanium, aluminum, zinc, nickel, tin, and those alloys can be used.

[0017](5) The formation process of the test chamber 40 (drawing 3 (E))
The test chamber 40 is formed by removing a part of insulating layer 11 through the opening 21 of the gate electrode 20, so that the working pole 5 may be exposed. The method of forming a mask by the photoresist method and forming by etching etc. as a formation process of the test chamber 40, is employable. How the above-mentioned window part 9 serves as the test chamber 40 may be adopted by forming the insulating layer 11 which has the window part 9 as a formation process of the test chamber 40, and laminating this to the insulating substrate 3.

[0018](6) Form the discrimination layer 6 on the working pole 5 after forming the formation process test chamber 40 of the discrimination layer 6. A biochemistry reaction is carried out with a substance under test, and the discrimination layer 6 is made to support the biological substance which generates oxygen or hydrogen peroxide. As a process which makes the discrimination layer 6 support a biological substance, the well-known method is applicable, For example, the entrapping elasticity which makes a biological substance include in a polymers matrix, the covalent binding procedure fixed using a living thing substance and the substance which carries out a covalent bond, the adsorption process which makes a biological substance stick to an insoluble film, etc. are employable. Here, since the discrimination layer 6 is formed in the bottom of the test chamber 40, it forms the sol-like polymers object which supported the biological substance, and can form it suitably by making this sol-like polymers object into the primary detecting element 5a of the working pole 5 under **. As a biological substance, a microorganism other than various kinds of enzymes, etc. can be used, and the substance under test corresponding to this can be measured.

[0019]Next, the measuring method and operation by the above-mentioned biosensor are

explained. First, predetermined inter-electrode voltage is impressed between the working pole 5 and the counter electrode 30, and the predetermined gate voltage which forms the potential barrier for eliminating an interfering substance is impressed also to the gate electrode 20. In this state, the induction part 1 of a biosensor is immersed in a solution under test. Through the opening 21 of the gate electrode 20, a solution under test is filled in the test chamber 40, and the working pole 5 and the counter electrode 30 flow through it. The substance under test in the solution under test filled in the test chamber 40 performs a biochemistry reaction by the catalysis of the biological substance supported to the discrimination layer 6, consumes oxygen or generates hydrogen peroxide. Current can flow into the working pole 5 and the counter electrode 30 by change accompanying this reaction, and a substance under test can be measured based on this current. In this measurement, even if electrified interfering substances, such as an ionic substance and a reducing substance, are contained in this solution under test besides the substance under test, the above-mentioned biochemistry reaction is not affected. That is, predetermined gate voltage is impressed to the gate electrode 20, and the potential barrier is formed around the opening 21.

It acts so that this potential barrier may not reach the discrimination layer 6 located in the lower part of the test chamber 40 in an interfering substance.

Therefore, the potential barrier of the gate electrode 20 can eliminate the influence on the biochemistry reaction by an interfering substance, and exact measurement of a substance under test can be performed.

[0020]Since a potential barrier can be formed in the uniform much more and stabilized distribution when the opening 21 of the gate electrode 20 is formed slit shape and in the shape of a lattice, the effect of exclusion of an interfering substance can be heightened.

[0021]The following experiments were conducted in order to investigate <the example of an experiment>, next the effect of exclusion of the interfering substance by the above-mentioned gate electrode 20.

[0022]The induction part 1 of the biosensor was created by the following processes. First, the insulating substrate 3 was formed in the size with a 50 mm by 50 mm× thickness of 1 mm with the glass substrate. Next, the mask was formed by photoresist, used vacuum deposition on the insulating substrate 3 which the mask is not made, 0.3 micrometer in thickness was made to vapor-deposit Pt, and the working pole 5 was formed. The size of the primary detecting element 5a of the working pole 5 is 2 mm by 2 mm. Next, the insulating layer 11 was formed by applying polyimide resin (Toray Industries [, Inc.] make: trade name Foto Nice) to 3 micrometers in thickness on the insulating substrate 3. Then, the gate electrode 20 was formed in 0.5 micrometer in thickness with vacuum deposition etc. so that it might have the opening 21 on the insulating layer 11. Then, the mask was formed by the photoresist method on the gate electrode 20 and the insulating layer 11, the portion of the insulating layer 11 was etched through the opening 21 of the gate electrode 20 by which a mask is not carried out, and the test chamber 40 was formed. Next, the discrimination layer 6 was formed by melting and isolating glucose oxidase to albumin, carrying out this isolated substance under **, and drying it.

[0023]Next, the induction part 1 of the biosensor was immersed in the solution (sample solution) under test having contained the substance under test and the interfering substance, and measurement of a substance under test and the influence of an interfering substance were investigated.

[0024]The following conditions were adopted as an experimental condition at this time. Ascorbic acid was used as an interfering substance, using glucose as a substance of a solution under test under test. And it investigated to the sample solution about three cases when [which impressed gate voltage VG of 0.2V or 0.4V to the gate electrode 20] not case and impressing.

[0025]The result of this experiment is shown in drawing 7. The vertical axis of drawing 7 shows a detected current value (muA), and a horizontal axis shows glucose concentration (mg/dl), respectively. The result showed the following things.

(1) By impressing suitable gate voltage VG, the detection current under the influence of ascorbic acid decreases, that is, the noise under the influence of ascorbic acid can be reduced.

(2) The linear dynamic range was able to be opened by removing the influence of ascorbic acid. By using this straight part showed that glucose concentration could be correctly measured based on a detected current value.

[0026]In the range which is not restricted to the above-mentioned example and does not deviate from that gist, this invention can be carried out in various modes, for example, the following modification is also possible for it.

[0027](1) In the example shown in drawing 1, although the gate electrode 20 was formed only one, not only this but two or more gate electrodes may be provided. That is, the example shown in drawing 4 and drawing 5 is an example which provided two gate electrodes.
It is the example which formed the insulating layer 13 on the 1st gate electrode 20, and formed the 2nd gate electrode 22 that has the opening 23 on this insulating layer 13.
In this example, if the 1st gate electrode 20 and 2nd gate electrode 22 are set as different potential and a potential barrier is formed, it will become possible to eliminate various interfering substances selectively.

[0028](2) Although the discrimination layer 6 was formed in the bottom of the test chamber 40 and the plate-like gate electrode 20 was formed in the upper part of the test chamber 40 in the example shown in drawing 1, the arrangement will not be asked if it is a gate electrode which forms the potential barrier over the discrimination layer 6. For example, as shown in drawing 6, the cylindrical working pole 51 and the counter electrode 53 may be supported to the support plate 55, the discrimination layer 57 may be formed in the periphery of the above-mentioned working pole 51, and it may cover with the gate electrode 59 which made the net tubed the circumference of this discrimination layer 57. Since the large touch area to the solution of the discrimination layer 57 under test can be taken according to this composition, it is effective in the ability to shorten measuring time.

[0029](3) As shown in drawing 1, when the opening 21 of the gate electrode 20 is narrow and a

solution under test is hard to fill in the test chamber 40, spreading formation of the polymer materials, such as polyvinyl acetate, may be carried out at the inner periphery of the opening 21, etc.

[0030] [Effect of the Invention]
According to this invention, as explained above, a gate electrode is formed in the circumference of a discrimination layer, and a potential barrier is formed by the voltage impressing to this gate electrode, and it acts so that this potential barrier may not make a discrimination layer approach to the electrifying substance in a solution under test. Therefore, since an interfering substance does not affect the biochemistry reaction of a living thing substance and a substance under test, or it does not act so that current may be sent through inter-electrode regardless of this biochemistry reaction, a substance under test can be measured correctly.

CLAIMS

[Claim(s)]
[Claim 1]A biosensor which measures a substance under test by measuring an electric variation accompanying a biochemistry reaction of a substance under test in a solution under test and a biological substance characterized by comprising the following.
One pair of electrodes.
A gate electrode in which voltage which forms a discrimination layer which was formed in one surface of this electrode, and supported the above-mentioned biological substance, and a potential barrier to which it is provided in the circumference of this discrimination layer, and an electrifying substance in a solution under test is made to **** is impressed.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]The top view showing the induction part of the biosensor concerning one example of this invention.

[Drawing 2]The sectional view which met the II-II line of drawing 1.

[Drawing 3]The explanatory view explaining the manufacturing process of the induction part of the biosensor concerning the example.

[Drawing 4]The top view showing the induction part of the biosensor concerning other examples.

[Drawing 5]The sectional view which met the V-V line of drawing 4.

[Drawing 6]The perspective view showing the induction part of the biosensor concerning the example of further others.

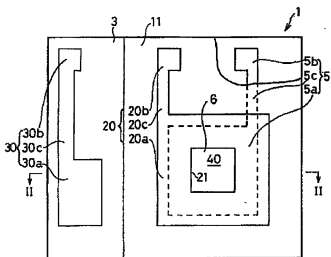[Drawing 7]The graph which shows the experimental result in the example of this invention.

[Drawing 8]The perspective view showing the induction part of the conventional biosensor.
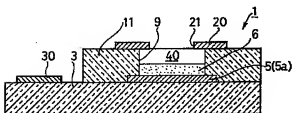
[Description of Notations]
1 -- Induction part
3 -- Insulating substrate
5 -- Working pole
5a -- Primary detecting element
5b -- Terminal area
5c -- Wiring section
6 -- Discrimination layer
9 -- Window part
11 -- Insulating layer
20 -- Gate electrode
20a -- Gate section
20b -- Terminal area
20c -- Wiring section
21 -- Opening
22 -- The 2nd gate electrode
30 -- Counter electrode
40 -- Test chamber
51 -- Working pole
53 -- Counter electrode
55 -- Support plate
57 -- Discrimination layer
59 -- Gate electrode
65 -- Discrimination layer

DRAWINGS

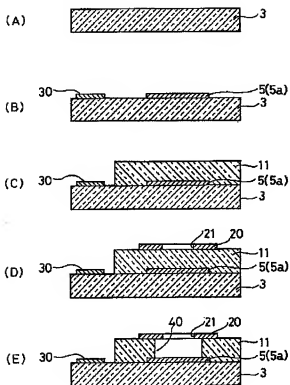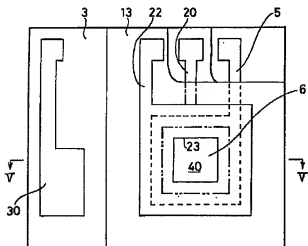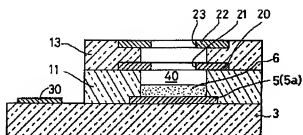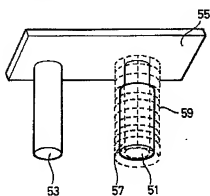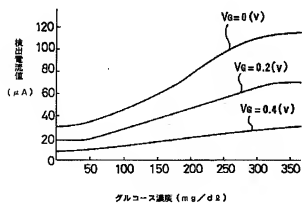[Drawing 1]

[Drawing 2]

[Drawing 3]

(A)

3

(B)

30
5(5a)
3

(C)

30
11
5(5a)
3

(D)

30
21 20
11
5(5a)
3

(E)

30
40 21 20
11
5(5a)
3

[Drawing 4]

3 13 22 20 5
6
23
40
V — V
30

[Drawing 5]

23 22 21 20
13
11
30 40
6
5(5a)
3

[Drawing 6]

55
59
53 57 51

[Drawing 7]

Vg=0(v)

120
100
80
60
40
20
0

検出電流値
（μA）

Vg=0.2(v)

Vg=0.4(v)

50 100 150 200 250 300 350

グルコース濃度（mg／dℓ）

[Drawing 8]